Monitoring Analytics

REPORT TO THE OHIO PUBLIC UTILITIES COMMISSION

Congestion in Ohio:

2020

The Independent Market Monitor for PJM

May 15, 2020

This page intentionally left blank.

Overview of Congestion Calculations

This report provides details of congestion in Ohio for the years 2017 through 2019. Congestion is defined to be load payments in excess of generation revenues, excluding marginal losses. Congestion calculations are for Ohio and not for any specific organization. The report includes congestion event hours for the constraints which had the largest impact on congestion in Ohio, either positive or negative, and the congestion costs associated with each constraint.[1]

Congestion is calculated on a constraint specific basis which reflects the differences between credits and charges caused by binding transmission limits on the power flow from generators, regardless of location, to load in Ohio. In this report, congestion equals the total congestion charges paid by load at the buses in Ohio minus the total congestion credits received by all generation that supplied that load, given the transmission constraints, regardless of location in the PJM system. Congestion charges and credits at specific buses are defined by the congestion component of LMP (CLMP) which is calculated when locational marginal prices (LMP) are calculated.

The congestion calculation reflects the underlying characteristics of the complete power system as it affects the defined area, including the nature and capability of transmission facilities, the offers and geographic distribution of generation facilities, the level and geographic distribution of incremental bids and offers and the geographic and temporal distribution of load.

In an LMP system, the only way to ensure that load receives the congestion revenues that load pays and that are not paid to generators is to use ARRs/FTRs, or an equivalent mechanism, to pay back to load the difference between the total load payments and the total generation revenues. FTRs were the mechanism initially selected in PJM to offset the congestion costs that load pays in an LMP market. Congestion revenues are the source of the funds to pay FTRs. Congestion revenues are assigned to the load that paid them through FTRs.

The current ARR/FTR design does not serve as an efficient way to ensure that load receives all the congestion revenues, and has the ability to receive the auction revenues

[1] Congestion event hours are hours in which a transmission constraint is binding. In day ahead, an interval equals one hour. In real time, an interval equals five minutes. In order to have a consistent metric for day-ahead and real-time congestion frequency, real-time congestion frequency is measured using the convention that an hour is constrained if any one of its component five-minute intervals is constrained.

associated with rights to all the potential congestion revenues. The current ARR/FTR rules (put into effect for the 2017/2018 planning period) allocate balancing congestion and M2M payments to load[2] and allocate annual net surplus day-ahead congestion and surplus FTR auction revenue to ARR holders.[3] If the current ARR/FTR allocation rules had been in place in the 2016/2017, 2017/2018 and 2018/2019 planning periods, ARRs and related self-scheduled FTRs that sunk in Ohio would have offset 42.4, 56.4 and 90.2 percent of congestion incurred by load in Ohio.

The ARR/FTR design does not serve as an efficient mechanism for returning congestion to load as a result of an FTR design that was flawed from its introduction and as a result of various distortions added to the design since its introduction. The distortions include the use of generation to load paths to define the rights to congestion, the definition of target allocations based on day-ahead congestion only, the failure to assign all FTR auction revenues to ARR holders, differences between modeled and actual system capability and numerous cross subsidies among participants.

If the original PJM FTR approach had been designed to return congestion revenues to load without use of the generation to load paths, and if the distortions subsequently introduced into the FTR design not been added, many of the subsequent issues with the FTR design would have been avoided. The design should simply have provided for the return of all congestion revenues to load. This would eliminate much of the complexity associated with ARRs and FTRs and eliminate unnecessary controversy about the appropriate recipients of congestion revenues.

Locational Marginal Price (LMP)

Components

LMP at a bus reflects the incremental price of energy at that bus. LMP at any bus can be deconstructed into three components: the system marginal price (SMP); the marginal loss component of LMP (MLMP); and the congestion component of LMP (CLMP).

SMP, MLMP and CLMP result from the least cost, security constrained dispatch of system resources to meet system load. SMP is the incremental cost of energy, given the current dispatch and given the choice of reference bus, or LMP net of losses and congestion. Losses refer to energy lost to physical resistance in the transmission and

---

2 On September 15, 2016, FERC ordered PJM to allocate balancing congestion to load, rather than to FTRs, to modify PJM's Stage 1A ARR allocation process and to continue to use portfolio netting. 153 FERC ¶ 61,180.

3 163 FERC ¶61,165 (2018).

distribution network as power is moved from generation to load. Total losses refer to the total system wide losses as a result of moving power from injections to withdrawals on the system. Marginal losses are the incremental change in system losses caused by changes in the system load and generation patterns.[4] The marginal loss associated with meeting load at a specific bus is the MLMP at that bus. The CLMP at a bus reflects the incremental cost of relieving transmission constraints, while maintaining system power balance, at that bus.

CLMP is the incremental price of congestion at each bus, based on the shadow prices associated with the relief of binding constraints in the security constrained optimization. CLMPs are positive or negative depending on bus location relative to binding constraints and relative to the load-weighted reference bus. In an unconstrained system CLMPs are zero. The relative values of SMP and CLMP are arbitrary and depend on the choice of reference bus.

Positive or negative CLMPs caused by a specific constraint at a specific bus indicate whether that constraint results in a higher or lower LMP at that bus relative to the system marginal price, at the reference bus. The total CLMP at a specific bus is the net sum of the positive and negative CLMPs caused by all binding constraints affecting that bus. Whether CLMP credits or charges associated with generation or load at a bus are positive or negative is determined by whether the total CLMP is positive or negative at that bus. CLMPs are not congestion. CLMPs are a component of LMP at a bus that indicate whether the LMP at that bus is higher or lower than the system marginal load weighted average price for energy (SMP) due to binding transmission constraints.

Congestion occurs when available, least-cost energy cannot be delivered to all loads because transmission facilities are not adequate to deliver that energy. When the least-cost available energy cannot be delivered to load in a transmission constrained area, higher cost units in the constrained area must be dispatched to meet that load. The result is that the price of energy in the constrained area is higher than in the unconstrained area because of the combination of transmission limitations and the cost of local generation. Congestion is the difference between the total cost of energy paid by load in the transmission constrained area and the total revenue received by generation to provide that energy. Congestion equals the sum of day-ahead and balancing congestion.

---

[4] The first derivative of total losses with respect to the power flow equals marginal losses. For additional information, see the *MMU Technical Reference for PJM Markets*, at "Marginal Losses," <http://www.monitoringanalytics.com/reports/Technical_References/docs/2010-som-pjm-technical-reference.pdf>.

Table 1 shows the real-time, load-weighted average LMP components for PJM and for Ohio for 2012 through 2019.[5]

Table 1 PJM and Ohio real-time, load-weighted average LMP components (Dollars per MWh): 2012 through 2019

	PJM				Ohio			
	Real-Time LMP	Energy Component	Congestion Component	Loss Component	Real-Time LMP	Energy Component	Congestion Component	Loss Component
2012	$35.23	$35.18	$0.04	$0.01	$33.70	$34.94	($0.85)	($0.39)
2013	$38.66	$38.64	$0.01	$0.02	$37.96	$38.43	($0.06)	($0.40)
2014	$53.14	$53.13	($0.02)	$0.02	$47.04	$52.42	($4.90)	($0.48)
2015	$36.16	$36.11	$0.04	$0.02	$33.65	$35.74	($1.81)	($0.29)
2016	$29.23	$29.18	$0.04	$0.01	$29.20	$29.07	($0.03)	$0.15
2017	$30.99	$30.96	$0.02	$0.01	$30.78	$30.78	($0.07)	$0.07
2018	$38.24	$38.19	$0.04	$0.02	$38.81	$37.82	$0.92	$0.06
2019	$27.32	$27.28	$0.02	$0.02	$28.49	$27.24	$0.94	$0.31

Table 2 shows the day-ahead, load-weighted average LMP components for PJM and for Ohio for 2012 through 2019.

Table 2 PJM and Ohio day-ahead, load-weighted average LMP components (Dollars per MWh): 2012 through 2019

	PJM				Ohio			
	Day-Ahead LMP	Energy Component	Congestion Component	Loss Component	Day-Ahead LMP	Energy Component	Congestion Component	Loss Component
2012	$34.55	$34.46	$0.11	($0.01)	$33.19	$34.33	($0.59)	($0.55)
2013	$38.93	$38.79	$0.13	$0.00	$37.13	$38.70	($1.22)	($0.34)
2014	$53.62	$53.38	$0.26	($0.02)	$48.53	$53.24	($4.47)	($0.25)
2015	$36.73	$36.51	$0.24	($0.01)	$34.02	$36.26	($2.12)	($0.13)
2016	$29.68	$29.55	$0.14	($0.01)	$29.45	$29.45	($0.06)	$0.06
2017	$30.85	$30.81	$0.05	($0.02)	$30.97	$30.71	$0.18	$0.08
2018	$37.97	$37.83	$0.16	($0.01)	$38.43	$37.50	$0.81	$0.12
2019	$27.23	$27.17	$0.08	($0.01)	$28.37	$27.13	$0.91	$0.32

Table 3 shows the real-time, monthly, load-weighted average CLMP components of LMP for PJM and for Ohio for 2012 through 2019.

[5] See *2020 Quarterly State of the Market Report for PJM: January through March*, Section 11: Congestion and Marginal Losses.

Table 3 PJM and Ohio real-time, monthly, load-weighted average CLMP component (Dollars per MWh): 2012 through 2019

	PJM								Ohio							
	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019
Jan	$0.02	$0.03	($0.01)	$0.02	$0.03	$0.01	$0.05	$0.02	($1.19)	($3.29)	($36.31)	($3.13)	($2.01)	($1.16)	($12.00)	($0.93)
Feb	$0.01	$0.02	($0.33)	($0.02)	$0.02	$0.02	$0.01	$0.01	($0.75)	($1.08)	($4.65)	($18.07)	($1.17)	$0.15	$0.02	$0.40
Mar	$0.04	$0.02	($0.06)	($0.00)	$0.04	$0.03	$0.04	$0.03	$0.15	($1.29)	($10.10)	($3.04)	$0.74	$0.40	$2.00	$0.45
Apr	$0.07	$0.01	$0.02	$0.03	$0.07	$0.01	$0.04	$0.02	$0.09	($0.40)	$0.25	$0.45	$0.99	$0.08	$1.81	$0.32
May	$0.05	$0.03	$0.04	$0.13	$0.02	$0.02	$0.09	$0.02	($0.91)	($0.89)	$1.44	$0.73	($0.38)	$0.70	$9.84	$0.88
Jun	$0.03	$0.03	$0.03	$0.06	$0.02	$0.01	$0.04	$0.01	($0.74)	($0.82)	$0.23	$1.34	$0.25	($0.62)	$4.06	$0.66
Jul	$0.04	($0.00)	$0.01	$0.02	$0.03	$0.02	$0.02	$0.02	($1.90)	$0.78	($1.65)	$0.39	($0.40)	$0.76	$1.20	$0.34
Aug	$0.02	$0.00	$0.01	$0.02	$0.04	$0.01	$0.02	$0.01	($2.23)	($0.95)	$0.25	$0.12	$0.54	$0.50	$0.90	$0.92
Sep	$0.07	($0.05)	$0.02	$0.04	$0.07	$0.08	$0.06	$0.05	($0.62)	$11.37	($0.16)	($0.50)	$0.83	$3.50	$3.17	$3.36
Oct	$0.06	$0.02	$0.05	$0.06	$0.06	$0.02	$0.03	$0.05	$0.87	($0.39)	($0.30)	$0.76	$0.69	$0.50	$0.73	$3.92
Nov	$0.03	$0.00	$0.05	$0.05	$0.02	$0.01	$0.03	$0.04	($1.62)	($0.96)	($1.15)	$0.60	$0.29	($0.11)	$0.51	$1.62
Dec	$0.01	($0.02)	$0.02	$0.04	$0.02	($0.01)	$0.01	$0.02	($0.65)	($1.99)	$0.07	$0.70	($0.33)	($4.93)	$0.45	($0.09)
Annual	$0.04	$0.01	($0.02)	$0.04	$0.04	$0.02	$0.04	$0.02	($0.85)	($0.06)	($4.90)	($1.81)	($0.03)	($0.07)	$0.92	$0.94

Table 4 shows the day-ahead, monthly, load-weighted average CLMP components of LMP for PJM and for Ohio for 2012 through 2019.

Table 4 PJM and Ohio day-ahead, monthly, load-weighted average CLMP component (Dollars per MWh): 2012 through 2019

	PJM								Ohio							
	2012	2013	2014	2015	2016	2017	2018	2019	2012	2013	2014	2015	2016	2017	2018	2019
Jan	$0.07	$0.12	$0.76	$0.38	$0.19	$0.08	$0.56	$0.22	($0.80)	($2.53)	($34.52)	($3.68)	($1.88)	($0.79)	($9.24)	($0.31)
Feb	$0.10	$0.04	$0.30	$0.77	$0.17	$0.01	$0.06	$0.03	($0.54)	($1.55)	($3.98)	($21.64)	($1.38)	$0.04	$0.59	$0.48
Mar	$0.07	$0.03	$0.19	$0.29	$0.07	$0.01	($0.07)	$0.06	$0.09	($1.18)	($5.81)	($2.25)	$0.63	$0.14	$1.32	$0.55
Apr	$0.08	$0.03	$0.02	($0.06)	$0.04	($0.02)	($0.01)	$0.02	$0.05	($0.57)	($0.13)	$0.49	$0.76	$0.08	$1.45	$0.54
May	$0.10	$0.10	$0.14	$0.20	$0.06	($0.06)	($0.05)	($0.01)	($0.12)	($0.90)	($0.02)	$0.67	($0.07)	$0.41	$3.47	$0.82
Jun	$0.17	$0.18	$0.23	$0.30	$0.16	$0.10	$0.11	$0.02	($1.33)	($0.88)	$0.08	$0.73	$0.22	($0.17)	$3.60	$0.45
Jul	$0.20	$0.29	$0.23	$0.18	$0.26	$0.13	$0.05	$0.19	($1.05)	($1.18)	($1.82)	$0.25	($0.37)	$0.49	$2.32	$0.83
Aug	$0.10	$0.09	$0.12	$0.12	$0.29	$0.03	$0.17	$0.08	($1.29)	($0.77)	($0.25)	$0.27	$0.14	$0.77	$0.93	$0.80
Sep	$0.18	$0.34	$0.18	$0.23	$0.19	$0.03	$0.15	$0.06	($0.57)	($2.20)	($0.43)	$0.12	$0.63	$2.52	$2.83	$2.45
Oct	$0.03	$0.06	$0.27	$0.10	$0.06	$0.02	$0.27	$0.03	$0.24	($0.33)	($0.09)	$0.77	$0.74	$1.46	$1.40	$2.44
Nov	$0.09	$0.07	$0.36	$0.09	($0.01)	$0.06	$0.24	$0.02	($0.78)	($1.17)	($0.95)	$0.56	$0.54	$0.35	$0.97	$1.58
Dec	$0.05	$0.20	$0.14	$0.09	$0.13	$0.16	$0.33	$0.15	($0.59)	($1.29)	$0.07	$0.54	($0.26)	($2.73)	$0.99	$0.58
Annual	$0.11	$0.13	$0.26	$0.24	$0.14	$0.05	$0.16	$0.08	($0.59)	($1.22)	($4.47)	($2.12)	($0.06)	$0.18	$0.81	$0.91

Congestion

Congestion Accounting

Total congestion costs equal net implicit CLMP charges, plus net explicit CLMP charges, plus net inadvertent CLMP charges. Implicit CLMP charges equal implicit withdrawal charges less implicit injection credits. Explicit CLMP charges are the net CLMP charges associated with the injection credits and withdrawal charges for point to point energy transactions. Inadvertent CLMP charges are common costs, not directly attributable to specific participants that are distributed on a load ratio basis. Each of these categories of congestion costs is comprised of day-ahead and balancing congestion costs. Congestion occurs in the day-ahead and real-time energy markets. Day-ahead congestion costs are based on day-ahead MWh while balancing congestion costs are based on deviations

between day-ahead and real-time MWh priced at the congestion price in the real-time energy market.

Implicit CLMP charges are the CLMP charges calculated for energy injected or withdrawn at a location. The explicit CLMP charges are the CLMP charges calculated for transactions with a defined source and a sink. For example, implicit CLMP charges are calculated for network load and explicit CLMP charges are calculated for up to congestion transactions (UTCs). Inadvertent CLMP charges are CLMP charges resulting from the differences between the net actual energy flow and the net scheduled energy flow into or out of the PJM control area each hour.

The congestion costs associated with specific constraints are the sum of the total day-ahead and balancing congestion costs associated with those constraints. Zonal congestion or congestion for a state is calculated on a constraint by constraint basis. The congestion calculations are the total difference between what the zonal load or state load pays in CLMP charges and what the generation that serves that load is paid, regardless of whether the zone or state is a net importer or a net exporter of generation. Congestion costs can be both positive and negative and CLMP charges and CLMP credits can be both positive and negative. CLMP charges, positive or negative, are paid by withdrawals and CLMP credits, positive or negative, are paid to injections. Total congestion costs (the total of charges less credits), when positive, measure the net congestion payment by a participant group and when negative, measure the net congestion credit paid to a participant group. Explicit CLMP charges, when positive, measure the congestion payment to a PJM member and when negative, measure the CLMP credit paid to a PJM member. Explicit CLMP charges are calculated for up to congestion transactions (UTCs).

The accounting definitions can be misleading. Load pays congestion. Congestion is the difference between what withdrawals (load) are paying for energy and what injections (generation) are being paid for energy due to binding transmission constraints. Generation does not pay congestion. Some generation receives a price lower than SMP and some generation receives a price greater than SMP but that does not mean that generation is paying congestion. It means that generation is being paid an LMP that is higher or lower than the system load-weighted average LMP.

The total congestion caused by a constraint is equal to the product of the constraint shadow price times the net flow on the binding constraint. Total congestion caused by the constraint can also be calculated using the CLMPs caused by the constraint at every bus and the net MW injections or MW withdrawals at every affected bus. Congestion associated with a specific constraint is equal to load CLMP charges (CLMP of that specific constraint at each bus times load MW at each bus) caused by that constraint in excess of generation CLMP credits (CLMP of that specific constraint at each bus times generation MW at each bus) caused by that constraint.

Constraint specific CLMPs are determined relative to a reference bus, where there is no congestion and no losses. For purposes of allocating the congestion of an individual constraint, the reference bus for each constraint calculation is moved to the point that is just upstream of the constraint (the bus with the greatest negative price effect from the constraint), allowing any positive price effects of the constraint to be reflected as a positive CLMP.

Congestion is allocated to downstream (positive CLMP) load buses that paid the congestion caused by the constraint, in proportion to the CLMP charges collected from that load due to that constraint. The congestion collected from each load bus due to a constraint is equal to the CLMP caused by that constraint times the MW of load at that load bus. This calculation is done for both day-ahead congestion and balancing congestion.

The system marginal price (SMP) is uniform for all areas, while the total of the congestion components of Locational Marginal Price (LMP) will either be positive or negative in a specific area, meaning that actual LMPs are above or below the SMP.[6] The area affected by a constraint will have increased prices and the unconstrained area will have lower prices.

Day-ahead CLMP charges and credits are based on MWh and CLMP in the Day-ahead energy market. Balancing CLMP charges and credits are based on load or generation deviations between the day-ahead and real-time energy markets and CLMP in the real-time energy market. If a participant has real-time generation or load that is greater than its day-ahead generation or load then the deviation will be positive. If there is a positive load deviation at a bus where real-time CLMP is positive, positive balancing congestion costs will result. Similarly, if there is a positive load deviation at a bus where real-time CLMP is negative, negative balancing congestion costs will result. If a participant has real-time generation or load that is less than its day-ahead generation or load then the deviation will be negative. If there is a negative load deviation at a bus where real-time CLMP is positive, negative balancing congestion costs will result. Similarly, if there is a negative load deviation at a bus where real-time CLMP is positive, negative balancing congestion costs will result.

In order to provide a more detailed explanation of the congestion calculations from which the total CLMP charges are derived, each category of congestion is defined and a

---

[6] The SMP is the price of the distributed load reference bus. The price at the reference bus is equivalent to the five minute real-time or hourly day-ahead load-weighted PJM LMP.

table of the CLMP charges or credits associated with each category is provided at the end of the report.[7]

The explicit CLMP charges calculated for Ohio represent the charges associated with point to point transactions that source or sink in Ohio. For example, if a transaction is sourced in Pennsylvania and sinks in Ohio, the charges would be based on the MWh of the transaction multiplied by the difference between the sink CLMP and the source CLMP. The resulting CLMP charges are allocated to the zone and state of the sink location, in Ohio. The sink location is the buyer's location and reflects the cost to the buyer of the internal purchase or external transaction.

Table 5 shows the combined day-ahead and balancing withdrawal charges, injection credits, and explicit CLMP charges for Ohio for 2017 through 2019.

Table 5 Total congestion costs (Dollars (Millions)) for Ohio by category: 2017 through 2019

	Congestion Costs (Millions)			
	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total
2017	$37.5	($69.9)	($3.7)	$103.8
2018	$60.8	($199.9)	($8.3)	$252.4
2019	$50.2	($68.2)	($6.6)	$111.9

Table 6 shows the congestion costs categories separated by day-ahead and balancing to show the contributions from both the day-ahead and real-time markets for 2017 through 2019.

Table 6 Total day-ahead and balancing congestion costs (Dollars (Millions)) for Ohio by category: 2017 through 2019

	Congestion Costs (Millions)								
	Day-Ahead				Balancing				
	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Grand Total
2017	$32.1	($81.6)	($0.3)	$113.4	$5.4	$11.7	($3.4)	($9.6)	$103.8
2018	$58.6	($209.3)	($2.6)	$265.2	$2.2	$9.4	($5.7)	($12.9)	$252.4
2019	$49.0	($78.1)	$10.6	$137.6	$1.3	$9.9	($17.1)	($25.8)	$111.9

[7] For details of CLMP accounting, see *2020 Quarterly State of the Market Report for PJM: January through March*, Section 11: Congestion and Marginal Losses.

Table 7 Monthly congestion costs (Dollars (Millions)) for Ohio: 2017 through 2019

	Congestion Costs (Millions)								
	2017			2018			2019		
	Day-ahead	Balancing	Total	Day-ahead	Balancing	Total	Day-ahead	Balancing	Total
Jan	$8.4	($1.2)	$7.2	$85.2	$3.9	$89.1	$19.3	($4.0)	$15.4
Feb	$7.1	($0.1)	$7.0	$7.0	$0.3	$7.3	$5.9	($0.9)	$5.0
Mar	$8.1	($0.6)	$7.5	$14.6	$0.0	$14.6	$7.1	($2.3)	$4.8
Apr	$3.9	($0.3)	$3.5	$14.0	($0.4)	$13.6	$5.3	($0.7)	$4.6
May	$7.0	($0.8)	$6.2	$27.5	($3.3)	$24.2	$9.1	($1.8)	$7.3
Jun	$9.4	($0.1)	$9.4	$23.5	($3.5)	$20.0	$6.0	($1.3)	$4.7
Jul	$7.0	($2.0)	$5.0	$16.2	($1.2)	$15.0	$14.6	($1.3)	$13.3
Aug	$7.4	($1.0)	$6.5	$13.9	($0.5)	$13.3	$8.3	($1.1)	$7.2
Sep	$15.6	($0.4)	$15.2	$21.5	($1.3)	$20.2	$20.4	($4.8)	$15.6
Oct	$8.5	$0.3	$8.8	$19.1	($2.4)	$16.7	$16.2	($2.7)	$13.5
Nov	$9.3	($0.7)	$8.6	$11.4	($2.8)	$8.6	$13.9	($3.3)	$10.7
Dec	$21.7	($2.8)	$18.9	$11.3	($1.5)	$9.8	$11.4	($1.6)	$9.8
Total	$113.4	($9.6)	$103.8	$265.2	($12.9)	$252.4	$137.6	($25.8)	$111.9

Table 8 lists the top 15 constraints affecting Ohio congestion costs for 2019.

Table 8 provides the type of constraints (Line, Transformer, Flowgate, or Interface), the location of the constraints and the congestion cost for the period analyzed. [8]

[8] All the interfaces and the Mid-Atlantic 500 kV system are put in the 500 category for location. The Mid-Atlantic 500 kV system includes equipment that is located in the PENELEC, PPL, BGE, PEPCO, MetEd, PECO, PSEG, JCPL, DPL and AECO zones.

Table 8 Congestion cost (Dollars (Millions)) details for the top 15 constraints affecting Ohio congestion costs: 2019

			Congestion Costs (Millions)								
			Day-Ahead				Balancing				
Constraint	Type	Location	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Grand Total
Conastone - Peach Bottom	Line	500	$24.8	($0.5)	$0.0	$25.3	$0.8	$1.3	$0.6	$0.1	$25.4
Conastone	Other	500	$3.8	($0.1)	$0.1	$4.0	($0.2)	($0.8)	($0.2)	$0.3	$4.3
Tanners Creek - Miami Fort	Flowgate	MISO	($1.5)	($5.4)	$0.1	$4.0	$0.0	$0.0	$0.0	$0.0	$4.0
Graceton - Safe Harbor	Line	BGE	$3.2	$0.1	$0.0	$3.2	$0.1	$0.2	$0.1	($0.1)	$3.1
Coolspring - Milford	Line	DPL	($0.6)	($2.9)	$0.0	$2.4	($0.0)	($0.1)	($0.1)	($0.0)	$2.4
Roxana - Praxair	Flowgate	MISO	($0.3)	($0.9)	$0.6	$1.2	$0.6	$0.7	($3.4)	($3.6)	($2.3)
Wescosville	Transformer	PPL	$1.4	($1.4)	($0.0)	$2.8	($0.0)	$0.4	($0.1)	($0.5)	$2.3
Bagley - Graceton	Line	BGE	$1.7	($0.5)	$0.0	$2.2	$0.1	$0.1	$0.1	$0.0	$2.2
AP South	Interface	500	$1.4	($0.9)	($0.0)	$2.2	$0.0	$0.1	$0.0	($0.0)	$2.2
Conastone - Northwest	Line	BGE	$1.5	($0.6)	$0.1	$2.3	$0.0	($0.0)	($0.1)	($0.1)	$2.2
Nottingham	Other	PECO	$2.7	$0.6	($0.0)	$2.1	$0.0	$0.0	$0.0	$0.0	$2.1
Logtown - North Delphos	Line	AEP	($3.2)	($4.9)	$0.3	$2.0	$0.0	($0.0)	($0.0)	($0.0)	$2.0
Palisades - Argenta	Flowgate	MISO	($0.1)	($2.1)	$0.1	$2.1	($0.0)	($0.0)	($0.2)	($0.2)	$1.9
PA Central	Interface	500	$0.2	($2.0)	$0.1	$2.4	$0.1	$0.6	($0.0)	($0.6)	$1.8
East	Interface	500	($0.8)	($2.9)	$0.0	$2.1	$0.1	$0.6	$0.1	($0.3)	$1.7
Top 15 Total			$34.3	($24.5)	$1.5	$60.2	$1.5	$3.1	($3.2)	($4.8)	$55.4
All Other Constraints			$14.7	($53.6)	$9.1	$77.4	($0.3)	$6.8	($13.9)	($20.9)	$56.5
Total			$49.0	($78.1)	$10.6	$137.6	$1.3	$9.9	($17.1)	($25.8)	$111.9

Table 9 lists the top 15 constraints affecting Ohio congestion costs for 2019. Table 9 provides the type of constraint (Line, Transformer, Flowgate, or Interface), the location of the constraint, the congestion event hours and congestion component of LMP contributed by the constraints for the period analyzed.

Table 9 Top 15 constraints affecting Ohio congestion costs: 2019

			Event Hours		Congestion Component	
Constraint	Type	Location	Day-Ahead	Real-Time	Day-Ahead	Real-Time
Conastone - Peach Bottom	Line	500	4,999	3,249	$0.26	$0.27
Conastone	Other	500	255	229	$0.03	$0.05
Tanners Creek - Miami Fort	Flowgate	MISO	882	-	$0.09	$0.00
Graceton - Safe Harbor	Line	BGE	1,631	563	$0.03	$0.03
Coolspring - Milford	Line	DPL	312	42	($0.02)	($0.03)
Roxana - Praxair	Flowgate	MISO	1,274	603	$0.08	$0.09
Wescosville	Transformer	PPL	200	164	($0.01)	($0.04)
Bagley - Graceton	Line	BGE	826	126	$0.01	$0.01
AP South	Interface	500	178	31	($0.06)	($0.01)
Conastone - Northwest	Line	BGE	289	29	$0.01	$0.00
Nottingham	Other	PECO	809	-	$0.03	$0.00
Logtown - North Delphos	Line	AEP	617	13	$0.01	$0.00
Palisades - Argenta	Flowgate	MISO	738	91	$0.02	$0.01
PA Central	Interface	500	872	654	$0.01	$0.01
East	Interface	500	113	16	($0.03)	($0.04)
Top 15 Total			13,995	5,810	$0.45	$0.35
All Other Constraints			48,930	14,177	$0.46	$0.59
Total			62,925	19,987	$0.91	$0.94

Table 10 shows the congestion cost details of the top 15 constraints affecting Ohio for 2018. Table 10 provides the type of constraints (Line, Transformer, Flowgate, or Interface), the location of the constraints and the congestion cost for the period analyzed.

Table 10 Congestion cost (Dollars (Millions)) details for the top 15 constraints affecting Ohio: 2018

			Congestion Costs (Millions)								
			Day-Ahead				Balancing				
Constraint	Type	Location	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Grand Total
AEP - DOM	Interface	500	$8.0	($9.5)	($0.8)	$16.8	$1.9	$2.7	$1.3	$0.5	$17.3
Tanners Creek - Miami Fort	Flowgate	MISO	($4.8)	($21.5)	($0.6)	$16.1	$0.0	$0.0	$0.0	$0.0	$16.1
Cloverdale	Transformer	AEP	$8.1	($7.1)	($0.1)	$15.1	($0.3)	$0.1	$0.6	$0.2	$15.4
Graceton - Safe Harbor	Line	BGE	$19.9	$6.5	$0.6	$14.0	$0.2	$1.0	($0.4)	($1.2)	$12.8
Batesville - Hubble	Flowgate	MISO	($2.9)	($12.5)	($2.3)	$7.3	($0.1)	($0.5)	$0.0	$0.4	$7.7
Lakeview - Greenfield	Line	ATSI	($5.5)	($15.2)	($0.4)	$9.2	($0.3)	$1.7	$0.1	($1.9)	$7.3
Conastone - Peach Bottom	Line	500	$6.7	$0.2	($0.0)	$6.5	$0.4	$0.2	($0.0)	$0.2	$6.7
Pleasant View - Ashburn	Line	Dominion	$3.4	($1.6)	($0.2)	$4.8	$0.2	$0.2	$0.1	$0.1	$5.0
5004/5005 Interface	Interface	500	($1.9)	($6.6)	($0.5)	$4.2	$0.1	$0.2	$0.2	$0.1	$4.3
Wescosville	Transformer	PPL	$0.6	($3.7)	($0.2)	$4.1	$0.1	$0.0	$0.2	$0.2	$4.3
Nottingham	Other	PECO	$4.6	$0.7	$0.2	$4.1	$0.0	$0.0	$0.0	$0.0	$4.1
Gable Switch Station - South Cadiz	Line	AEP	$3.8	($0.3)	$0.2	$4.4	$0.2	$0.3	($0.2)	($0.3)	$4.0
Delaware - Hogan	Line	AEP	$2.0	($2.1)	$0.5	$4.6	($0.2)	$0.2	($0.4)	($0.7)	$3.8
Bedington - Black Oak	Interface	500	$1.7	($2.3)	($0.2)	$3.8	$0.1	$0.1	$0.1	$0.1	$3.8
Maple - Jackson	Line	ATSI	($3.1)	($6.7)	$0.5	$4.1	$0.1	$0.2	($0.2)	($0.3)	$3.8
Top 15 Total			$40.8	($81.8)	($3.5)	$119.1	$2.3	$6.5	$1.5	($2.7)	$116.4
All Other Constraints			$17.8	($127.5)	$0.8	$146.1	($0.1)	$2.9	($7.2)	($10.2)	$135.9
Total			$58.6	($209.3)	($2.6)	$265.2	$2.2	$9.4	($5.7)	($12.9)	$252.4

Table 11 lists the top 15 constraints affecting Ohio congestion costs for 2018. Table 11 provides the type of constraints (Line, Transformer, Flowgate, or Interface), the location of the constraints, the congestion event hours and congestion component of LMP contributed by the constraints for the period analyzed.

Table 11 Top 15 constraints affecting Ohio congestion costs: 2018

			Event Hours		Congestion Component	
Constraint	Type	Location	Day-Ahead	Real-Time	Day-Ahead	Real-Time
AEP - DOM	Interface	500	720	150	($0.50)	($0.70)
Tanners Creek - Miami Fort	Flowgate	MISO	1,511	-	$0.33	$0.00
Cloverdale	Transformer	AEP	615	99	($0.32)	($0.30)
Graceton - Safe Harbor	Line	BGE	3,361	2,040	$0.15	$0.19
Batesville - Hubble	Flowgate	MISO	254	134	$0.28	$0.15
Lakeview - Greenfield	Line	ATSI	1,356	352	($0.05)	($0.08)
Conastone - Peach Bottom	Line	500	1,100	422	$0.07	$0.05
Pleasant View - Ashburn	Line	Dominion	303	33	($0.03)	($0.02)
5004/5005 Interface	Interface	500	175	47	($0.18)	($0.08)
Wescosville	Transformer	PPL	476	172	($0.02)	($0.04)
Nottingham	Other	PECO	1,157	-	$0.05	$0.00
Gable Switch Station - South Cadiz	Line	AEP	284	106	$0.05	$0.07
Delaware - Hogan	Line	AEP	1,225	235	$0.01	$0.01
Bedington - Black Oak	Interface	500	316	52	($0.09)	($0.05)
Maple - Jackson	Line	ATSI	1,000	155	$0.13	$0.10
Top 15 Total			13,853	3,997	($0.12)	($0.70)
All Other Constraints			60,688	17,819	$0.93	$1.63
Total			74,541	21,816	$0.81	$0.92

Table 12 shows the congestion cost details of the top 15 constraints affecting Ohio for 2017. Table 12 provides the type of constraints (Line, Transformer, Flowgate, or Interface), the location of the constraints and the congestion cost for the period analyzed.

Table 12 Congestion cost (Dollars (Millions)) details for the top 15 constraints affecting Ohio: 2017

			Congestion Costs (Millions)								
			Day-Ahead				Balancing				
Constraint	Type	Location	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Implicit Withdrawal Charges	Implicit Injection Credits	Explicit Charges	Total	Grand Total
Conastone - Peach Bottom	Line	500	$9.0	$0.4	$0.0	$8.6	$0.4	$0.3	$0.4	$0.5	$9.1
Graceton - Safe Harbor	Line	BGE	$6.2	$1.5	$0.0	$4.7	$0.3	$0.5	$0.3	$0.2	$4.8
Carson - Rawlings	Line	Dominion	$2.9	($0.8)	$0.2	$3.9	$0.2	$0.3	($0.2)	($0.3)	$3.6
Conastone - Otter Creek	Line	PPL	$5.2	$1.9	($0.1)	$3.1	$0.3	$0.4	$0.3	$0.2	$3.4
AP South	Interface	500	$2.3	($1.4)	($0.4)	$3.4	($0.0)	$0.2	$0.1	($0.1)	$3.3
Conastone - Northwest	Line	BGE	$2.7	($0.2)	($0.1)	$2.8	$0.1	$0.2	$0.2	$0.1	$3.0
Butler - Shanor Manor	Line	APS	($2.8)	($5.5)	$0.3	$3.0	$0.4	$0.4	($0.1)	($0.1)	$2.9
5004/5005 Interface	Interface	500	($1.2)	($4.7)	($0.5)	$3.1	$0.5	$1.3	$0.5	($0.3)	$2.8
Lakeview - Greenfield	Line	ATSI	($0.9)	($3.6)	$0.0	$2.7	$0.0	$0.1	$0.1	($0.1)	$2.6
Westwood	Flowgate	MISO	($3.1)	($5.4)	$0.2	$2.5	$0.3	$0.2	($0.1)	($0.0)	$2.4
Three Mile Island	Transformer	500	$1.3	($0.8)	($0.0)	$2.1	($0.0)	($0.1)	$0.2	$0.3	$2.4
Alpine - Belvidere	Flowgate	MISO	($0.5)	($2.9)	($0.2)	$2.2	$0.0	$0.0	$0.0	$0.0	$2.2
Batesville - Hubble	Flowgate	MISO	($1.3)	($4.7)	($1.1)	$2.3	($0.0)	($0.3)	($0.4)	($0.1)	$2.2
Tanners Creek - Miami Fort	Line	AEP	($0.2)	($1.8)	($0.0)	$1.6	($0.1)	($0.0)	$0.4	$0.3	$1.9
Lake George - Aetna	Flowgate	MISO	($0.2)	($1.9)	($0.3)	$1.3	($0.5)	$0.2	$1.2	$0.6	$1.9
Top 15 Total			$19.3	($29.9)	($2.0)	$47.2	$1.9	$3.6	$2.9	$1.2	$48.5
All Other Constraints			$12.8	($51.6)	$1.7	$66.1	$3.5	$8.1	($6.3)	($10.8)	$55.3
Total			$32.1	($81.6)	($0.3)	$113.4	$5.4	$11.7	($3.4)	($9.6)	$103.8

Table 13 lists the top 15 constraints affecting Ohio congestion costs for 2017. Table 13 provides the type of constraint (Line, Transformer, Flowgate, or Interface), the location of the constraint, the congestion event hours and congestion component of LMP contributed by the constraint for the period analyzed.

Table 13 Top 15 constraints affecting the Ohio congestion costs: 2017

			Event Hours		Congestion Component	
Constraint	Type	Location	Day-Ahead	Real-Time	Day-Ahead	Real-Time
Conastone - Peach Bottom	Line	500	3,159	840	$0.09	$0.09
Graceton - Safe Harbor	Line	BGE	3,118	1,146	$0.06	$0.08
Carson - Rawlings	Line	Dominion	720	231	($0.06)	($0.05)
Conastone - Otter Creek	Line	PPL	1,336	869	$0.06	$0.08
AP South	Interface	500	1,315	75	($0.10)	($0.06)
Conastone - Northwest	Line	BGE	975	228	$0.02	$0.02
Butler - Shanor Manor	Line	APS	1,877	266	$0.12	$0.10
5004/5005 Interface	Interface	500	173	105	($0.12)	($0.18)
Lakeview - Greenfield	Line	ATSI	1,593	164	($0.02)	($0.02)
Westwood	Flowgate	MISO	2,182	198	($0.01)	$0.00
Three Mile Island	Transformer	500	540	86	$0.01	$0.01
Alpine - Belvidere	Flowgate	MISO	339	-	($0.00)	$0.00
Batesville - Hubble	Flowgate	MISO	379	158	$0.11	$0.19
Tanners Creek - Miami Fort	Line	AEP	1,213	63	$0.02	$0.02
Lake George - Aetna	Flowgate	MISO	483	243	($0.03)	($0.05)
Top 15 Total			19,402	4,672	$0.16	$0.22
All Other Constraints			115,918	16,624	$0.02	($0.29)
Total			135,320	21,296	$0.18	($0.07)

ARRs/FTRs as a Congestion Offset in Ohio

ARRs are allocated to zonal load based on historical generation to load transmission paths, in many cases based on pre 1999 information. ARRs are allocated within zones based on zonal base load (Stage 1A) and zonal peak loads (other Stages). ARR revenue is the result of the prices that result from the sale of FTRs through the FTR auctions. ARR revenue for each zone is the revenue for the ARRs that sink in each zone.

Congestion paid by load in a zone is the total difference between what the zonal load pays in CLMP charges net of payments to the generation that serves the zonal load.

Table 14 shows the congestion offsets paid to load in Ohio: the allocation of ARR revenue; self scheduled FTR revenue; and the allocation of end of planning year surplus. Table 14 also shows payments by load in Ohio: the allocation of balancing congestion; the allocation of M2M payments. The total offset available to load, which is the revenue load receives to offset their congestion charges, is the sum of all of those credits and charges.

Table 14 shows day-ahead congestion and balancing congestion paid by load in Ohio, plus the allocation of M2M charges.[9]

The zonal offset percentage shown in Table 14 is the sum of the congestion related revenues (offset) paid to load in Ohio divided by the total congestion payment made by load in Ohio, including M2M payments.

Table 14 Ohio ARR and FTR total congestion offset (in millions) for ARR holders: 2016/2017, 2017/2018 and 2018/2019 planning period <<NC Offset.xlsx FINAL>>

Planning Period	ARR Credits	FTR Credits	Balancing+ M2M Charge	Surplus Allocation	Total Offset	Day Ahead Congestion	Balancing Congestion	M2M Payments	Total Congestion	Offset
2016/2017	$ 40.8	$ 26.3	$ (21.2)	$ 7.3	$ 53.2	$ 147.8	$ (13.9)	$ (8.6)	$ 125.3	42.4%
2017/2018	$ 34.7	$ 62.7	$ (24.4)	$ 40.9	$ 113.9	$ 227.2	$ (6.0)	$ (19.4)	$ 201.7	56.4%
2018/2019	$ 101.3	$ 25.5	$ (27.9)	$ 22.2	$ 121.2	$ 163.7	$ (23.1)	$ (6.2)	$ 134.4	90.2%

The total congestion offset paid to load in Ohio was 42.4 percent of congestion costs in the 2016/2017 Planning Period, 56.4 percent in the 2017/2018 Planning Period and 90.2 in the 2018/2019 Planning Period. The amount of the offset varies significantly by zone and by bus. The offsets are a function of the assignment of ARRs and the valuation of ARRs in the FTR auctions. The results shown in Table 14 illustrate the fundamental issues with the FTR/ARR design in PJM. If ARRs were assigned correctly, based on actual zonal congestion, and if balancing congestion were appropriately included in total congestion, the zonal offsets to load would equal zonal congestion payments by load.

Conclusion

Total congestion decreased from 2018 to 2019. Day-ahead congestion was high in January 2018 as a result of high gas costs and high LMPs.

[9] See *2019 State of the Market Report* for PJM, Section 11: Congestion and Marginal Losses.

Table 15 Congestion Definitions

Congestion Category	Calculation
Day-Ahead Implicit Withdrawal CLMP Charges	Day-Ahead Demand MWh * Day-Ahead CLMP
Day-Ahead Implicit Injection CLMP Credits	Day-Ahead Supply MWh * Day-Ahead CLMP
Day-Ahead Explicit CLMP Charges	Day-Ahead Transaction MW * (Day-Ahead Sink CLMP - Day-Ahead Source CLMP)
Day-Ahead Total Congestion Costs	Day-Ahead Implicit Withdrawal CLMP Charges - Day-Ahead Implicit Injection CLMP Credits + Day-Ahead Explicit CLMP Charges
Balancing Implicit Withdrawal CLMP Charges	Balancing Demand MWh * Real-Time CLMP
Balancing Implicit Injection CLMP Credits	Balancing Supply MWh * Real-Time CLMP
Balancing Explicit CLMP Costs	Balancing Transaction MW * (Real-Time Sink CLMP - Real-Time Source CLMP)
Balancing Total Congestion Costs	Balancing Implicit Withdrawal CLMP Charges - Balancing Implicit Injection CLMP Credits + Balancing Explicit CLMP Costs
Total Congestion Costs	Day-Ahead Total Congestion Costs + Balancing Total Congestion Costs

MWh Category	Definition
Day-Ahead Demand MWh	Cleared Demand, Decrement Bids, Energy Sale Transactions
Day-Ahead Supply MWh	Cleared Generation, Increment Bids, Energy Purchase Transactions
Real-Time Demand MWh	Load and Energy Sale Transactions
Real-Time Supply MWh	Generation and Energy Purchase Transactions
Balancing Demand MWh	Real-Time Demand MWh - Day-Ahead Demand MWh
Balancing Supply MWh	Real-Time Supply MWh - Day-Ahead Supply MWh